VERDIGRIS BASIN TOTAL MAXIMUM DAILY LOAD

Waterbody: Chetopa Creek
Water Quality Impairment: Dissolved Oxygen

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: Upper Verdigris **County:** Wilson and Neosho

HUC 8: 11070101

HUC 11 (HUC 14s)**:** **050** (030)

Drainage Area: 56.8 square miles

Main Stem Segment: WQLS: 22 (Chetopa Creek) starting at confluence with the Verdigris River and traveling upstream to headwaters in west-central Neosho County (**Figure 1**).

Tributary Segment: Non-WQLS: Little Chetopa Creek (471)

Designated Uses: Expected Aquatic Life Support, Secondary Contact Recreation, and Food Procurement for Main Stem Segment 22.

1998 303(d) Listing: Table 1 - Predominant Non-point Source and Point Source Impacts

Impaired Use: Expected Aquatic Life Support

Water Quality Standard: Dissolved Oxygen (DO): 5 mg/L (KAR 28-16-28e(c)(2)(A))

2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Support for Designated Use under 1998 303(d): Not Supporting Aquatic Life

Monitoring Sites: Station 696 near Neodesha

Period of Record Used: 1996 and 2000 for Station 696; Some 2000 and all 2001 Kansas Biological Survey Data (**Figure 2**)

Flow Record: Marmaton River near Marmaton (USGS Station 06917380) matched to Chetopa Creek watershed at Chetopa Creek near Neodesha (USGS 07169550).

Long Term Flow Conditions: 10% Exceedance Flows = 70.7 cfs**,** 95% = 0 cfs

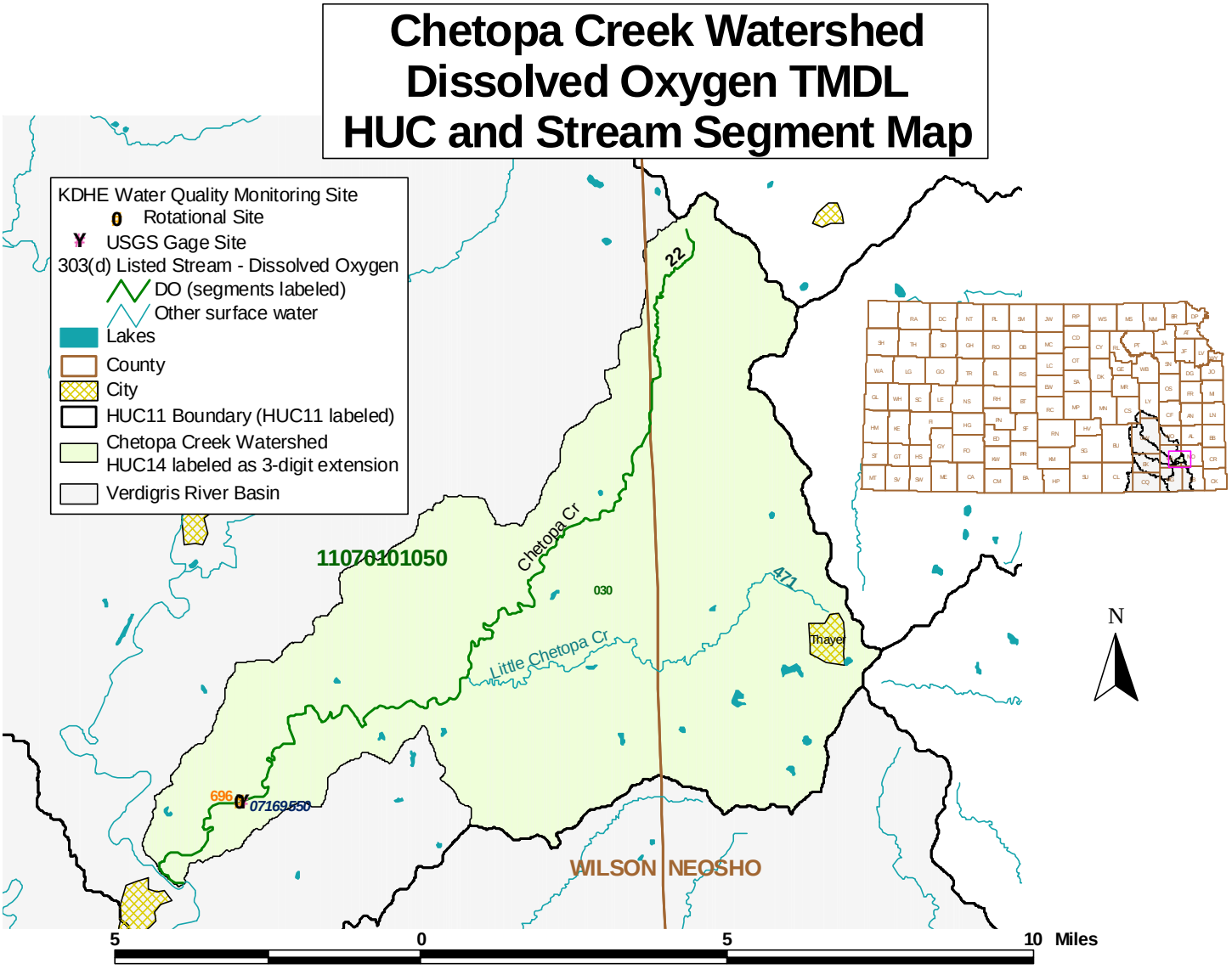
Chetopa Creek Watershed
Dissolved Oxygen TMDL
HUC and Stream Segment Map
KDHE Water Quality Monitoring Site
Rotational Site
USGS Gage Site
303(d) Listed Stream - Dissolved Oxygen
DO (segments labeled)
Other surface water
Lakes
County
City
HUC11 Boundary (HUC11 labeled)
Chetopa Creek Watershed
HUC14 labeled as 3-digit extension
Verdigris River Basin
11070101050
Chetopa Cr
030
Little Chetopa Cr
22
471
Thayer
696
07169550
WILSON
NEOSHO
N
5
0
5
10 Miles

Figure 1

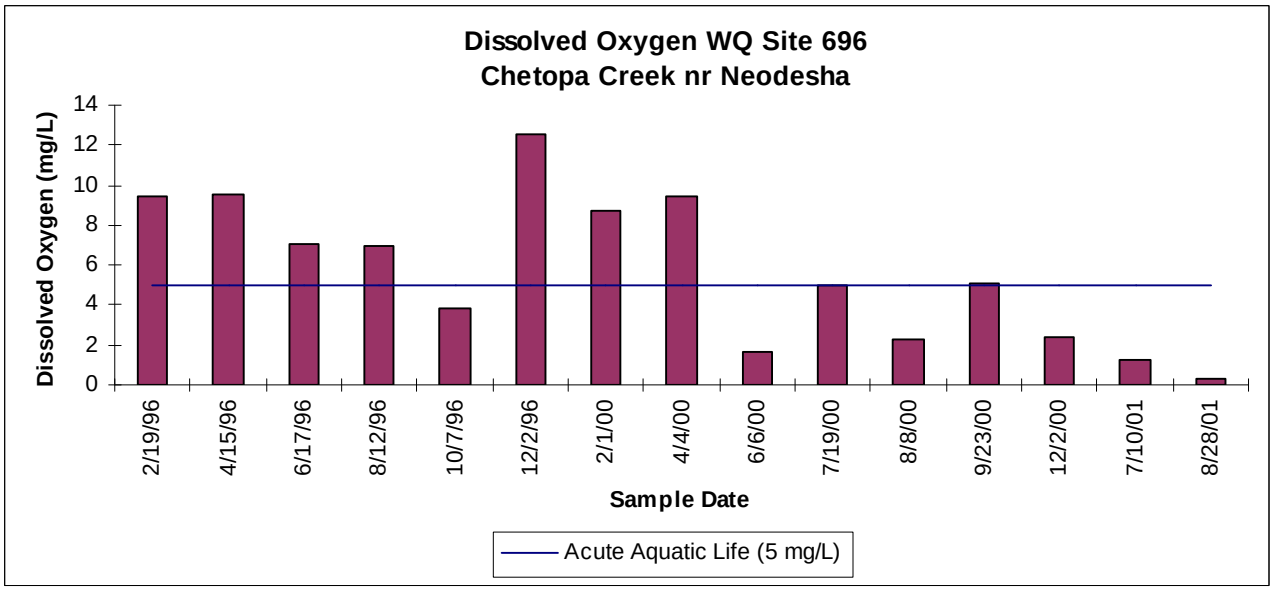

Figure 2

Current Conditions: Since loading capacity varies as a function of the flow present in the stream, this TMDL represents a continuum of desired loads over all flow conditions, rather than fixed at a single value. Sample data for the sampling site were categorized for each of the three defined seasons: Spring (Apr-Jul), Summer-Fall (Aug-Oct) and Winter (Nov-Mar). High flows and runoff equate to lower flow durations; baseflow and point source influences generally occur in the 75-99% range. Load curves were established for the Aquatic Life criterion by multiplying the flow values for Chetopa Creek near Neodesha along the curve by the applicable water quality criterion and converting the units to derive a load duration curve of pounds of DO per day. This load curve graphically displays the TMDL since any point along the curve represents water quality at the standard at that flow. Historic excursions from water quality standards (WQS) are seen as plotted points *below* the load curves. Water quality standards are met for those points plotting *above* the applicable load duration curves (**Figure 3**).

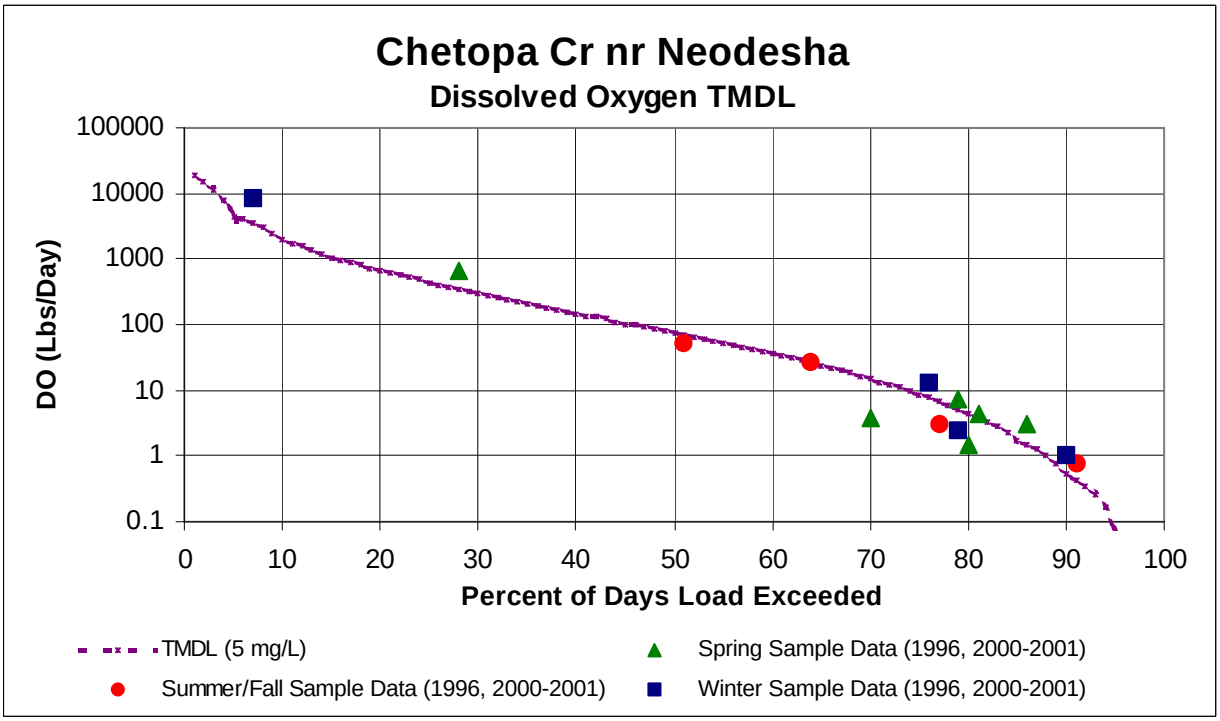

Figure 3

Excursions were seen each of the three defined seasons and are outlined in **Table 1**. Sixty percent of the Summer-Fall samples and 33% of the Spring samples were below the aquatic life criterion. Twenty five percent of the Winter samples were under the aquatic life criterion. Overall, 40% of the samples were under the criterion. This would represent a baseline condition of non-support of the impaired designated use.

No DO violations have been encountered at flows exceeding 2.6 cfs on Chetopa Creek near Neodesha, therefore a critical low flow can be identified on Chetopa Creek as those flows of 2.6 cfs or less.

Table 1
NUMBER OF SAMPLES UNDER DISSOLVED OXYGEN STANDARD OF 5 mg/L BY FLOW

Station	Season	0 to 10%	10 to 25%	25 to 50%	50 to 75%	75 to 90%	90 to 100%	Cum Freq.
Chetopa Creek near Neodesha (696)	Spring	0	0	0	0	1	0	2/6 = 33%
	Summer	0	0	0	1	1	0	3/5 = 60%
	Winter	0	0	0	0	0	0	1/4 = 25%

A watershed comparison approach was taken in developing this TMDL. The Big Creek watershed (Water Quality Sampling Site 611 in the watershed was not impaired by low DO) has similar land use characteristics (**see Table 2 in Appendix**) to the Chetopa Creek watershed, is about twice the size and is located east of the Chetopa Creek watershed in the Neosho River

Basin. The relationship of DO to ammonia, biochemical oxygen demand (BOD), fecal coliform bacteria (FCB), water temperature, turbidity, nitrate, phosphorus, pH and total suspended solids (TSS) were used in the comparison.

Table 3 in the Appendix outlines those water quality data for the samples taken on the same day for the two sites of interest. **Table 4 in the Appendix** is the subset of data from Table 3 for those sample dates when DO was below the aquatic life criterion for sample site 696. From Table 4 at site 696 the average phosphorus was slightly higher than the reference cite, while all other parameters were comparable. Although BOD at site 696 is higher than other sites in Southeast Kansas and the reduction of BOD should help reduce DO violations in Chetopa Creek, it is likely that low flow is the primary factor influencing DO violations in the Chetopa Creek watershed. The frequency with which low flow periods occur is likely due the watershed's small contributing area.

Desired Endpoints of Water Quality at Site 696 over 2007 - 2011

The desired endpoint will be a biochemical oxygen demand from artificial sources such that average BOD concentrations remain below 3.0 mg/l in the stream under the critical flow conditions which results in no excursions below 5 mg/l of DO detected between 2007 - 2011 attributed to these sources.

This desired endpoint should improve DO concentrations in the creek at the critical lower flows (0 - 2.6 cfs). Seasonal variation is accounted for by this TMDL, since the TMDL endpoint is sensitive to the low flow usually occurring in the June - November months.

This endpoint will be reached as a result of expected, though unspecified, reductions in organic loading from the various sources in the watershed resulting from implementation of corrective actions and Best Management Practices, as directed by this TMDL (see Implementation - Section 5). Sediment control practices such as buffer strips and grassed waterways should help reduce the non-point source BOD load under higher flows which, in turn, should help reduce the oxygen demand exerted by the sediment transported to the stream that may occur during the critical flow period. Achievement of this endpoint will provide full support of the aquatic life function of the creek and attain the dissolved oxygen water quality standard.

3. SOURCE INVENTORY AND ASSESSMENT

NPDES: There is one NPDES permitted wastewater discharger within the watershed upstream of site 696 (**Figure 4**). This system is outlined below in **Table 2**.

Table 2

DISCHARGING FACILITY	STREAM REACH	SEGMENT	DESIGN FLOW	TYPE
Thayer WTF	Little Chetopa Cr	471	0.076 mgd	Lagoon

Chetopa Creek Watershed
NPDES and Livestock Waste Management Facilities

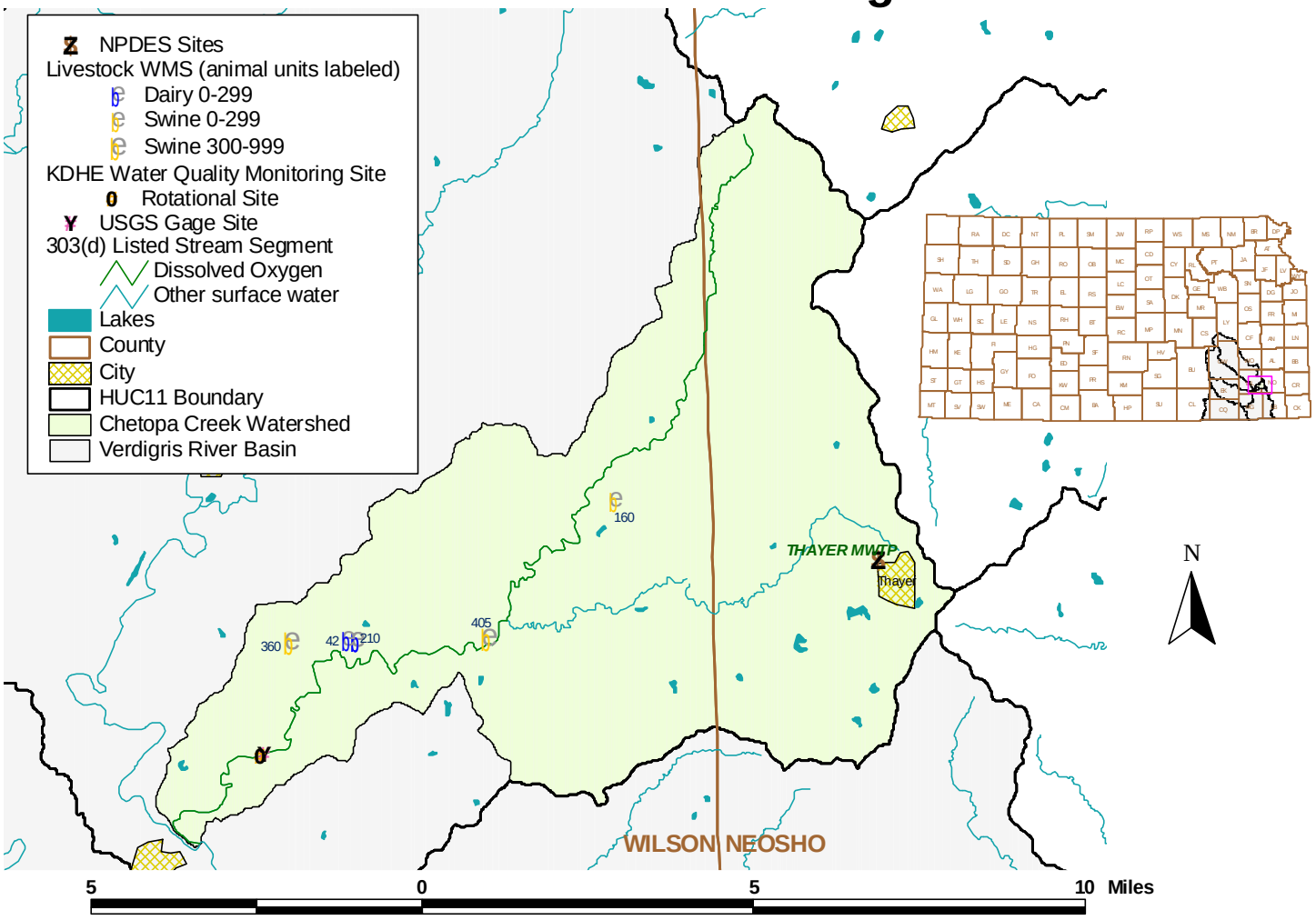

Figure 4

The city of Thayer relies on a three cell lagoon system with 120 day detention times for treatment of their wastewater. Kansas Implementation Procedures - Waste Water Permitting - indicates this lagoon meets standard design criteria which have been shown to consistently meet or exceed the bacteria standard.

The population projection for Thayer to the year 2020 indicate slight increases. Projections of future water use and resulting wastewater appear to be within the design flows for of the current system's treatment capacity. Examination of 1998, 1999, 2000 and 2001 effluent monitoring of the city of Thayer indicates that when the city does discharge (8 quarters out of the 12 quarters reported), BOD has been well within permit limits (30 mg/L). The stream flow estimates for

Chetopa Creek were reviewed for those dates (see attached flow condition review) that the city did discharge and it was noted that discharges usually occurred after large runoff events in the watershed, indicating that the city primarily contributes BOD loads to the stream outside of the critical flow period (0 - 2.6 cfs) identified for this TMDL. It is concluded that wastewater from Thayer was not likely the cause of DO impairments in Chetopa Creek

Livestock Waste Management Systems: Five operations are registered, certified or permitted within the watershed. These facilities (dairies or swine facilities) tend to be located toward the lower half of watershed along the main stem (**Figure 4**). All permitted livestock facilities have waste management systems designed to minimize runoff entering their operations or detaining runoff emanating from their areas. Such systems are designed for the 25 year, 24 hour rainfall/runoff event, which typically coincide with stream flows exceeded less than 1 - 5 % of the time. NPDES permits, also non-discharging, are issued for facilities with more than 1,000 animal units. None of the facilities in the watershed are of this size. Total potential animal units within the watershed for all facilities is 1,177. The actual number of animal units on site is variable, but typically less than potential numbers.

Land Use: Most of the watershed is grassland (49% of the area), cropland (41%), or woodland (8%). The cropland appears to be evenly distributed across the watershed. The grazing density estimate is average for the watershed when compared to densities elsewhere in the Verdigris Basin (37 animal units/mi^2) (**Figure 5 or Table 2 in Appendix**).

On-Site Waste Systems: The watershed's population density is average when compared to densities across the Verdigris Basin (18 person/mi^2) (**Figure 5**). The rural population projections for Wilson and Neosho counties through 2020 show slight to modest growth (10-22% increase, respectively). While failing on-site waste systems can contribute oxygen demanding substance loadings, their impact on the impaired segments is generally limited, given the small size of the rural population and magnitude of other sources in the watershed.

Background Levels: Some organic enrichment may be associated with environmental background levels, including contributions from wildlife and stream side vegetation, but it is likely that the density of animals such as deer is fairly dispersed across the watershed and that the loading of oxygen demanding material is constant along the stream. In the case of wildlife, this loading should result in minimal loading to the streams below the levels necessary to violate the water quality standards. In the case of stream side vegetation, the loading should be greater in the lower half of the watershed with its larger proportion of woodland near the stream.

Chetopa Creek Watershed
Land Use, Population and Grazing Density

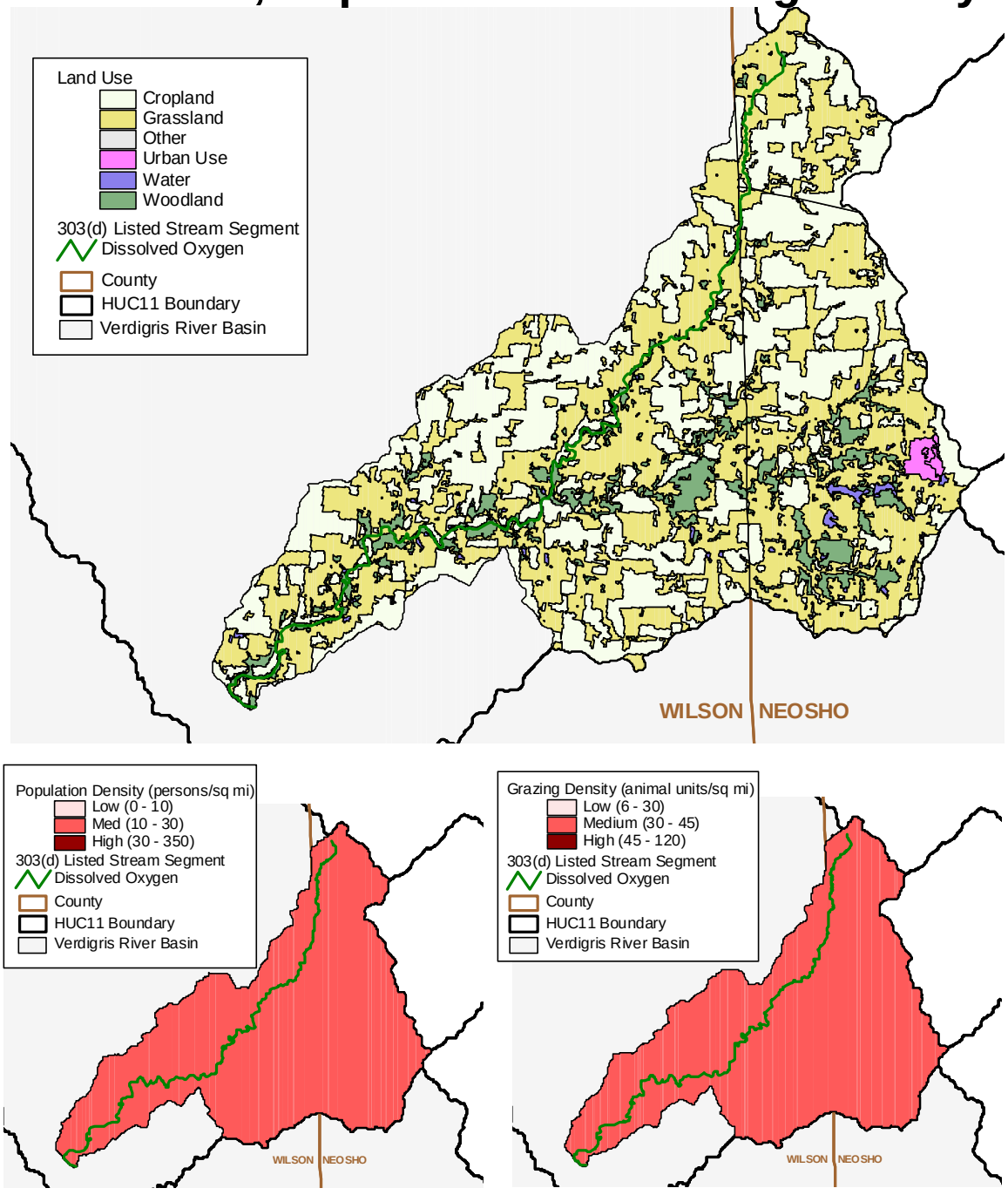

Figure 5

4. ALLOCATION OF POLLUTION REDUCTION RESPONSIBILITY

BOD is a measure of the amount of oxygen required to stabilize organic matter in a stream. As such, BOD is used as a benchmark measure to anticipate DO levels while it measures the total concentration of DO that will be demanded as organic matter degrades in a stream. It is presumed that reductions in BOD loads will reduce DO excursions under certain critical flow conditions. Therefore, any allocation of wasteloads and loads will be made in terms of BOD reductions. Yet, because DO is a manifestation of multiple factors, the initial pollution load reduction responsibility will be to decrease the BOD over the critical range of flows encountered on the Chetopa Creek system. Allocations relate to the BOD levels seen in the Chetopa Creek system at site 696 relative to other sites is Southeast Kansas for the critical lower flow conditions (0-2.6 cfs). Based on this relationship, BOD loads at site 696 need to be reduced so that in stream average BOD is 3.0 mg/L or less. Additional monitoring over time will be needed to further ascertain the relationship between BOD reductions of non-point sources, flow conditions, and DO levels along the stream.

For this phase of the TMDL the average condition is considered across the seasons to establish goals of the endpoint and desired reductions. Therefore, the target average BOD level was multiplied by the average daily flow for Chetopa Creek across all hydrologic conditions. This is represented graphically by the integrated area under the BOD load duration curve established by this TMDL. The area is segregated into allocated areas assigned to point sources (WLA) and nonpoint sources (LA). Future growth in wasteloads should be offset by reductions in the loads contributed by nonpoint sources. This offset, along with appropriate limitations, is expected to eliminate the impairment. This TMDL represents the “Best Professional Judgment” as to the expected relationship between physical factors, organic matter and DO.

Point Sources: Point sources are responsible for maintaining their systems in proper working condition and appropriate capacity to handle anticipated wasteloads of their respective populations. The State and NPDES permits will continue to be issued on 5 year intervals, with inspection and monitoring requirements and conditional limits on the quality of effluent released from these facilities. Ongoing inspections and monitoring of the systems will be made to ensure that minimal contributions have been made by this source.

Based upon the preceding assessment, only those discharging point sources (Thayer) contributing a BOD load in the Chetopa Creek watershed upstream of site 696 will be considered in this Wasteload Allocation. Effluent monitoring records from Thayer for 1998 - 2001 indicate the city has discharged about 66% of the time and these discharges have usually reflected runoff events within the watershed (Appendix).

Streeter-Phelps analyses for this point source indicates the present BOD permit limit (30 mg/L) for it maintains DO levels above 5 mg/L in the stream when there is no flow upstream of the discharge point (see attached Streeter-Phelps analysis).

The design flow of the point source (0.1 cfs) redefines the lowest flow seen at site 696 (83-99% exceedance), and the WLA equals the TMDL curve across this flow condition (**Figure 6**).

From this, the WLA for the city of Thayer is 19.1 lbs/day BOD which translates to an in stream WLA of 1.9 lbs/day BOD at Site 696 (**Figure 6**).

Non-Point Sources: Based on the prior assessment of sources, the distribution of excursions from water quality standards at site 696 and the relationship of those excursions to runoff conditions and seasons, non-point sources are also seen as a contributing factor to the occasional DO excursions in the watershed.

The samples from the Chetopa Creek watershed show there were no DO violations at flows in excess of 2.6 cfs. The Load Allocation assigns responsibility for reducing the in stream BOD levels at site 696 to 3.0 mg/L across the 0.1 - 2.6 cfs range of the critical flow condition (51 -82% exceedance) and maintaining the in stream BOD levels at site 628 to the historical levels of 3.8 mg/L for flows in excess of 2.6 cfs (which is 90^{th} percentile of BOD samples for flows in Chetopa Creek above 2.6 cfs near Neodesha). The LA equals zero for flows from 0 - 0.1 cfs (83 - 99% exceedance), since the flow at this condition is entirely effluent created, and then increases to the TMDL curve with increasing flow beyond 0.1 cfs (**Figure 6**). Sediment control practices such as buffer strips and grassed waterways should help reduce the non-point source BOD load under higher flows as well as reduce the oxygen demand exerted by the sediment transported to the stream that may occur during the critical flow period.

Defined Margin of Safety: The Margin of Safety will be implied based on conservative assumptions used in the permitting of the point source discharges including coincidence of low flow with maximum discharge from the treatment plant, associated CBOD content, temperature of the effluent, higher than expected stream velocity and the better than permitted performance of the treatment plant in producing effluent with BOD well below permit limits under critical seasonal conditions. Additionally, the target BOD concentration has been set at a conservative value since sampling data indicates exceeding this value has seldom led to a dissolved oxygen violation.

State Water Plan Implementation Priority: Because this watershed has indicated some problem with dissolved oxygen which has short term and immediate consequences for aquatic life, this TMDL will be a High Priority for implementation.

Unified Watershed Assessment Priority Ranking: This watershed lies within the Upper Verdigris Basin (HUC 8: 11070101) with a priority ranking of 58 (Low Priority for restoration work).

Priority HUC 11s and Stream Segments: Priority should be directed toward baseflow gaining stream segments along the main stem of Chetopa Creek (22), including Little Chetopa Creek (4).

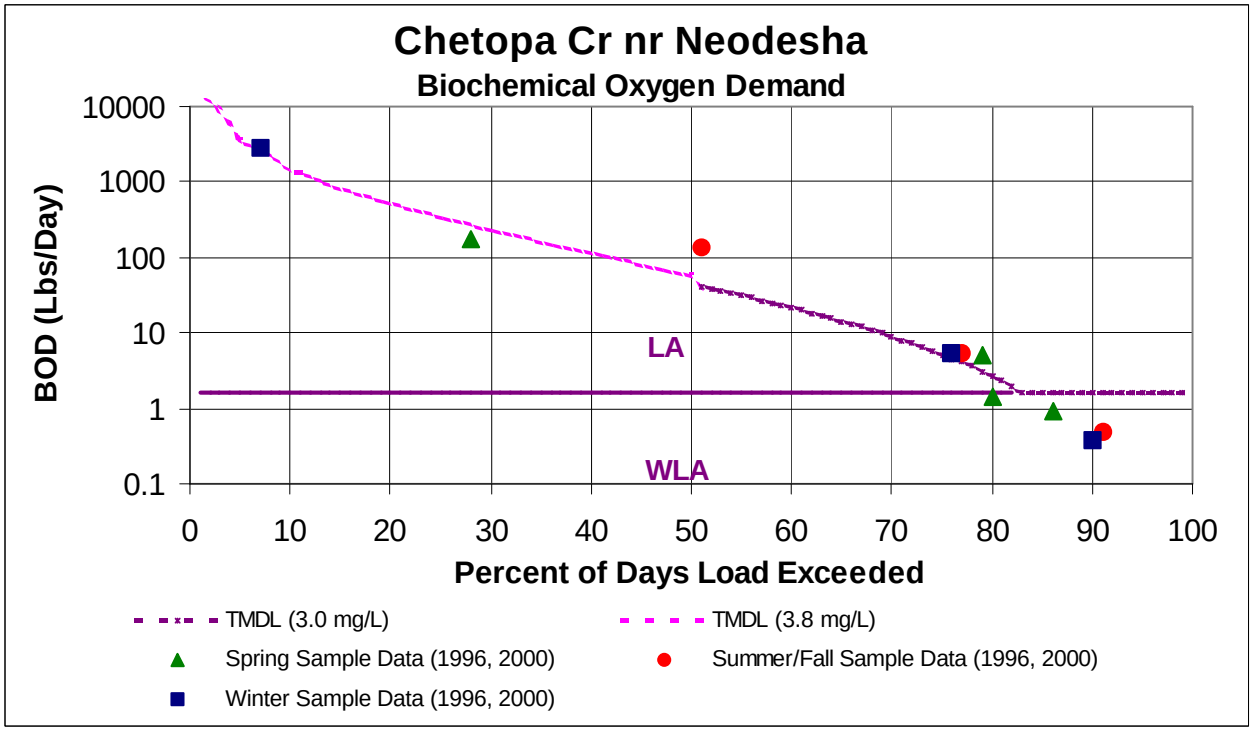

Figure 6

5. IMPLEMENTATION

Desired Implementation Activities

1. Where needed, restore riparian vegetation along target stream segments.
2. Install grass buffer strips where needed along streams.
3. Renew state and federal permits and inspect permitted facilities for permit compliance
4. Install proper manure and livestock waste storage.
5. Insure proper on-site waste system operations in proximity to targeted streams.
6. Insure that labeled application rates of chemical fertilizers are being followed.

Implementation Programs Guidance

NPDES and State Permits - KDHE

a. Municipal permits for facilities in the watershed will be renewed after 2006 with DO and BOD monitoring and permit limits preventing excursions in these criteria.

b. Develop a pilot study on the use of aerators to lower BOD levels in lagoon system effluent.

c. Livestock permitted facilities will be inspected for integrity of applied pollution prevention technologies.

d. Registered livestock facilities with less than 300 animal units will apply

pollution prevention technologies.
e. Manure management plans will be implemented to prevent introduction of organic material to the stream.

Non-Point Source Pollution Technical Assistance - KDHE

a. Support Section 319 demonstration projects for pollution reduction from livestock operations in watershed.
b. Provide technical assistance on practices geared to small livestock operations which minimize impact to stream resources.
c. Guide federal programs such as the Environmental Quality Improvement Program, which are dedicated to priority subbasins through the Unified Watershed Assessment, to priority stream segments within this TMDL.

Water Resource Cost Share & Non-Point Source Pollution Control Programs - SCC

a. Provide alternative water supplies to small livestock operations
b. Develop improved grazing management plans
c. Reduce grazing density on overstocked pasturelands
d. Install livestock waste management systems for manure storage
e. Implement manure management plans
f. Install replacement of on-site waste systems close to the priority streams.
g. Coordinate with USDA/NRCS Environmental Quality Improvement Program in providing educational, technical and financial assistance to agricultural producers.

Riparian Protection Program - SCC

a. Develop riparian restoration projects along targeted stream segments, especially those areas with baseflow.
b. Design winter feeding areas away from streams.

Buffer Initiative Program - SCC

a. Install grass buffer strips near streams.
b. Leverage Conservation Reserve Enhancement Program to hold riparian land out of production.

Extension Outreach and Technical Assistance - Kansas State University

a. Educate livestock producers on riparian and waste management techniques.
b. Provide technical assistance on livestock waste management design.
c. Continue Section 319 demonstration projects on livestock management.

Agricultural Outreach - KDA

a. Provide information on livestock management to commodity advocacy groups.
b. Support Kansas State outreach efforts.

Local Environmental Protection Program - KDHE

a. Inspect and repair on-site waste systems within 500 feet of priority stream segments.

Timeframe for Implementation: Pollution reduction practices should be installed along Chetopa Creek and base flow gaining tributaries in 2003-2007, with follow up implementation thereafter.

Targeted Participants: Primary participants for implementation will be the identified point sources and landowners immediately adjacent to the priority stream segments. Implemented activities should be targeted to those stream segments with greatest potential contribution to baseflow. Nominally, this would be most likely be:

1. Areas of denuded riparian vegetation along Chetopa Creek, Little Chetopa Creek and their contributing tributaries.
2. Facilities with inadequate water quality controls
3. Unbuffered cropland adjacent to stream
4. Sites where drainage runs through or adjacent livestock areas
5. Sites where livestock have full access to stream and stream is primary water supply
6. Poor riparian sites
7. Failing on-site waste systems

Some inventory of local needs should be conducted in 2003 to identify such activities. Such an inventory would be done by local program managers with appropriate assistance by commodity representatives and state program staff in order to direct state assistance programs to the principal activities influencing the quality of the streams in the watershed during the implementation period of this TMDL.

Milestone for 2007: The year 2007 marks the mid-point of the ten year implementation window for the watershed. At that point in time, milestones should be reached which will have at least two-thirds of the landowners responsible for riparian restoration or buffer strips, cited in the local assessment, participating in the implementation programs provided by the state. Additionally, sampled data from site 696 should indicate evidence of improved dissolved oxygen levels at the critical flow conditions below 1 cfs relative to the conditions seen over 1996 and 2000. Information on the ability of aerators to improve lagoon effluent quality should be available in 2007.

Delivery Agents: The primary delivery agents for program participation will be the conservation districts for programs of the State Conservation Commission and the Natural Resources Conservation Service. Producer outreach and awareness will be delivered by Kansas State County staff managing. On-site waste system inspections will be performed by Local Environmental Protection Program personnel for Wilson and Neosho counties.

Reasonable Assurances:

Authorities: The following authorities may be used to direct activities in the watershed to reduce pollution.

1. K.S.A. 65-164 and 165 empowers the Secretary of KDHE to regulate the discharge of sewage into the waters of the state.

2. K.S.A. 65-171d empowers the Secretary of KDHE to prevent water pollution and to protect the beneficial uses of the waters of the state through required treatment of sewage and established water quality standards and to require permits by persons having a potential to discharge pollutants into the waters of the state.

3. K.A.R. 28-16-69 to -71 implements water quality protection by KDHE through the establishment and administration of critical water quality management areas on a watershed basis.

4. K.S.A. 2-1915 empowers the State Conservation Commission to develop programs to assist the protection, conservation and management of soil and water resources in the state, including riparian areas.

5. K.S.A. 75-5657 empowers the State Conservation Commission to provide financial assistance for local project work plans developed to control non-point source pollution.

6. K.S.A. 82a-901, *et seq*. empowers the Kansas Water Office to develop a state water plan directing the protection and maintenance of surface water quality for the waters of the state.

7. K.S.A. 82a-951 creates the State Water Plan Fund to finance the implementation of the *Kansas Water Plan.*

8. The *Kansas Water Plan* and the Verdigris Basin Plan provide the guidance to state agencies to coordinate programs intent on protecting water quality and to target those programs to geographic areas of the state for high priority in implementation.

Funding: The State Water Plan Fund, annually generates $16-18 million and is the primary funding mechanism for implementing water quality protection and pollution reduction activities in the state through the *Kansas Water Plan*. The state water planning process, overseen by the Kansas Water Office, coordinates and directs programs and funding toward watersheds and water resources of highest priority. Typically, the state allocates at least 50% of the fund to programs supporting water quality protection. This TMDL is a High Priority consideration.

Effectiveness: Buffer strips are touted as a means to filter sediment before it reaches a stream and riparian restoration projects have been acclaimed as a significant means of stream bank stabilization. The key to effectiveness is participation within a finite subwatershed to direct resources to the activities influencing water quality. The milestones established under this TMDL are intended to gauge the level of participation in those programs implementing this TMDL.

Should participation significantly lag below expectations over the next five years or monitoring indicates lack of progress in improving water quality conditions from those seen over 1996 and 2000, the state may employ more stringent conditions on agricultural producers and urban runoff in the watershed in order to meet the desired endpoints expressed in this TMDL. The state has the authority to impose conditions on activities with a significant potential to pollute the waters

of the state under K.S.A. 65-171. If overall water quality conditions in the watershed deteriorate, a Critical Water Quality Management Area may be proposed for the watershed, in response.

6. MONITORING

KDHE will continue to collect bimonthly samples at rotational Station 696 in 2004 and 2008 including dissolved oxygen samples in order to assess progress and success in implementing this TMDL toward reaching its endpoint. Should impaired status remain, the desired endpoints under this TMDL may be refined and more intensive sampling may need to be conducted under specified low flow conditions over the period 2007-2011. Use of the real time flow data available at the Marmaton River near Marmaton stream gaging station can help direct these sampling efforts.

Monitoring of BOD levels in effluent will continue to be a condition of NPDES and state permits for facilities. This monitoring will continually assess the functionality of the systems in reducing organic levels in the effluent released to the streams.

Local program management needs to identify its targeted participants of state assistance programs for implementing this TMDL. This information should be collected in 2003 in order to support appropriate implementation projects.

7. FEEDBACK

Public Meetings: Public meetings to discuss TMDLs in the Verdigris Basin were held January 23 in Fredonia and March 6, 2002 in Neodesha. An active Internet Web site was established at http://www.kdhe.state.ks.us/tmdl/ to convey information to the public on the general establishment of TMDLs and specific TMDLs for the Verdigris Basin.

Public Hearing: A Public Hearing on the TMDLs of the Verdigris Basin was held in Neodesha on June 4, 2002.

Basin Advisory Committee: The Verdigris Basin Advisory Committee met to discuss the TMDLs in the basin on October 3, 2001, January 23 and March 6, 2002.

Milestone Evaluation: In 2007, evaluation will be made as to the degree of impairment which has occurred within the watershed and current condition of Chetopa Creek. Subsequent decisions will be made regarding the implementation approach and follow up of additional implementation in the watershed.

Consideration for 303(d) Delisting: The stream will be evaluated for delisting under Section 303(d), based on the monitoring data over the period 2007-2011. Therefore, the decision for delisting will come about in the preparation of the 2012 303(d) list. Should modifications be made to the applicable water quality criteria during the ten-year implementation period, consideration for delisting, desired endpoints of this TMDL and implementation activities may be adjusted accordingly.

Incorporation into Continuing Planning Process, Water Quality Management Plan and the Kansas Water Planning Process: Under the current version of the Continuing Planning Process, the next anticipated revision will come in 2003 which will emphasize implementation of TMDLs. At that time, incorporation of this TMDL will be made into both documents. Recommendations of this TMDL will be considered in *Kansas Water Plan* implementation decisions under the State Water Planning Process for Fiscal Years 2003-2007.

Appendix (Chetopa Creek DO TMDL)

Table 2

Chetopa Cr Watershed (696)			Big Creek Watershed (611)		
Land Use	Acres	% of Total	Land Use	Acres	% of Total
Cropland	15045	41.4	Cropland	27906	39.4
Grassland	17899	49.3	Grassland	40415	57.1
Urban Use	222	0.6	Urban Use	105	0.1
Water	339	0.9	Water	245	0.3
Woodland	2835	7.8	Woodland	2068	2.9
Total	36340	100	Total	70739	100

Table 3

COL_DATE	DISOXY		AMMONIA		BOD		FECCOLI		NITRATE		PHFIELD		TEMP_CENT		PHOSPHU		TSS		TURBIDITY		Flow (cfs)
	696	611	696	611	696	611	696	611	696	611	696	611	696	611	696	611	696	611	696	611	696
2/19/96	9.4	10.6	0.041	0.010	3.60	2.90	1	1	0.03	0.01	7.6	7.5	6	5	0.075	0.050	12	10	3.1	3.8	0.02
4/15/96	9.5	6.9	0.114	0.114	2.90	5.00	1	22	0.05	0.03	8.1	8.0	12	12	0.038	0.112	5	37	3.0	15.0	0.06
6/17/96	7.1	6.8	0.018	0.136	4.80	6.40	100	90	0.06	0.04	7.3	7.4	25	25	0.118	0.149	24	31	9.0	11.0	0.19
8/12/96	7.0	5.0	0.095	0.048	4.40	3.20	----	1200	0.22	0.15	7.5	7.6	24	22	0.209	0.125	58	21	24.0	10.0	0.02
10/7/96	**3.8**	7.7	0.149	0.167	9.50	7.60	9000	200	0.32	0.07	7.3	7.8	14	15	0.160	0.078	36	20	20.0	6.0	2.56
12/2/96	12.5	12.3	0.023	0.020	4.00	4.10	1000	800	1.19	0.70	7.5	7.5	5	5	0.223	0.183	36	24	54.0	46.0	129.47
2/1/00	8.7	10.7	0.040	0.020	3.63	2.28	10	20	0.01	0.01	7.1	7.7	3	4	0.090	0.070	4	3	2.6	3.0	0.28
4/4/00	9.4	10.4	0.020	0.020	2.43	3.06	230	100	0.18	0.34	7.9	8.0	12	12	0.070	0.060	23	15	10.0	6.5	13.06
6/6/00	**1.7**	6.0	0.020	0.020	1.62	4.65	150	100	0.09	0.11	7.6	8.1	21	27	0.180	0.120	9	25	3.6	5.4	0.16
8/8/00	**2.3**	8.0	0.020	0.020	4.05	2.73	100	240	0.08	0.14	7.5	7.9	27	28	0.120	0.070	17	10	7.9	5.0	0.25
Avg	7.1	8.4	0.054	0.058	4.1	4.2	1177	277	0.22	0.16	7.5	7.8	15	16	0.128	0.102	22	20	13.72	11.17	14.61

Table 4

COL_DATE	DISOXY		AMMONIA		BOD		FECCOLI		NITRATE		PHFIELD		TEMP_CENT		PHOSPHU		TSS		TURBIDITY		Flow (cfs)
	696	611	696	611	696	611	696	611	696	611	696	611	696	611	696	611	696	611	696	611	696
10/7/96	**3.8**	7.7	0.149	0.167	9.50	7.60	9000	200	0.32	0.07	7.3	7.8	14	15	0.160	0.078	36	20	20.0	6.0	2.56
6/6/00	**1.7**	6.0	0.020	0.020	1.62	4.65	150	100	0.09	0.11	7.6	8.1	21	27	0.180	0.120	9	25	3.6	5.4	0.16
8/8/00	**2.3**	8.0	0.020	0.020	4.05	2.73	100	240	0.08	0.14	7.5	7.9	27	28	0.120	0.070	17	10	7.9	5.0	0.25
Avg	2.6	7.2	0.063	0.069	5.1	5.0	3083	180	0.16	0.11	7.5	7.9	21	23	0.153	0.089	21	18	10.50	5.47	0.99

Thayer

Date	BOD	Average Daily Q	Flow Condition Comment
9/4/01	No Disch		
3/5/01	22.4	18	8 days after runoff peak of 685
12/5/00	12.5		Dry period
9/12/00	No Disch		
6/21/00	12.5	169	Runoff Peak
9/2/99	No Disch		
12/14/99	8.5	2.7	5 days after peak of 45
6/8/99	5.1	6.8	7 days after runoff peak of 427
12/1/98	15	39	Runoff peak
9/1/98	No Disch		
6/4/98	19		No peak with 14 days
3/10/98	7.75	30	2 days after runoff peak of 298

Streeter-Phelps DO Sag Model - ChetopaCrDO_Thayer
Single Reach - Single Load

Chetopa Creek

1 cfs = .0283 m^3/s

0.25 mph =0 .11176 m/s

		Elev (ft)	Dist to 696	Min DO	Crit Dist DO
0.0033337	Design Flow (Thayer)	1000	26.50	6.71	3.30

Elevation Correction (DO)

Elevation	**1000**	ft
Correctn Factor (DO_{sat})	0.968	mg/L

Distance (km)

Flow (m^3/s)

Unless modified by upstream pt. source, upstream BOD set as target for basin

Concentration (mg/L)

Upstream DO (where appropriate) elevation corrected and set at 90% sat.

Temp (C)

Velocity	0.11176		
BOD coef	0.23	Theta	1.056
O2 coef	3.66	Theta	1.024

Vel (m/s)

		Flow	BOD	DO	T	Dist	Slope (ft.mi)	Calc K_r	
1	**Thayer**	0.0033337	30	6.88	21.6	26.5	13.6	3.66	
	Upstream	0	0	0	0	-----			
	Result at Dist	0.0033337	15.07	7.46	23.3				Elev = 780 ft

Kr Values (Foree 1977) using	0.42 (0.63 + 0.4S^1.15)
for q < 0.05 where q = cfs/mi^2 and	S (ft/mile)